Tracking Marine Heatwaves Globally

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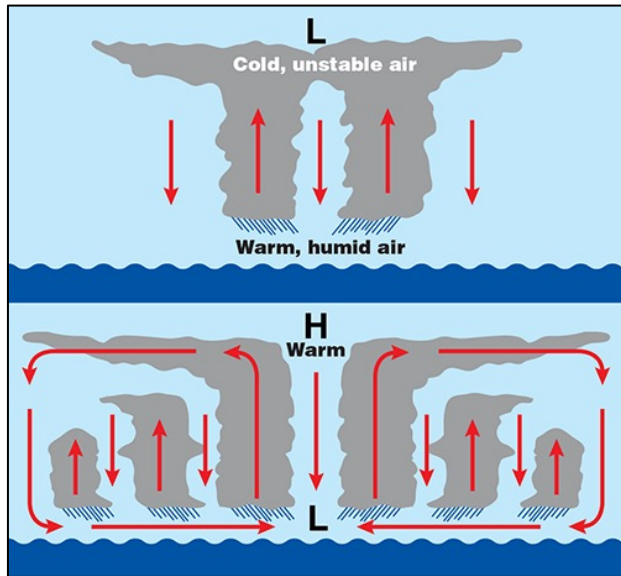
Daniel Whitt, *NASA/AMES*

David-John Gagne and Anna Depenmeier , *NCAR*
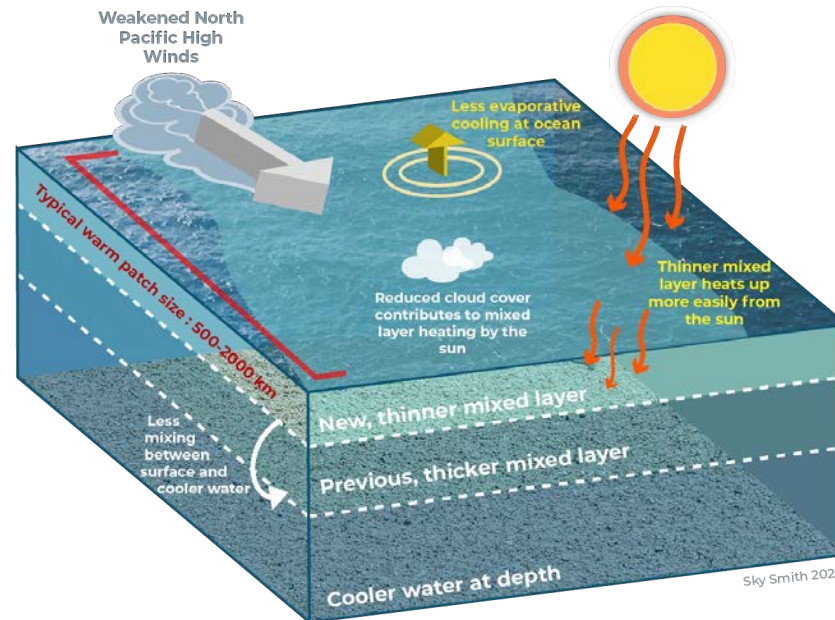
Gregory Johnson, *NOAA/PMEL*

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Unlike hurricanes and tornados, extreme events in the ocean are not well-defined dynamical features (although Strong El Nino's can be considered MHWs)
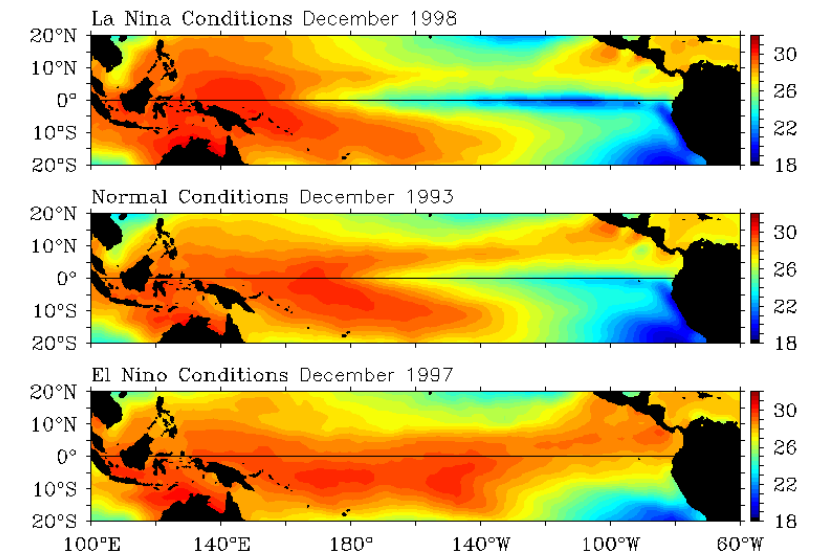
Hurricanes

Marine heatwaves

El Niño – Southern Oscillation

NOAA

California Sea Grant

NOAA

Hobday et al (2016) proposed definition of MHWs

1. Remove SST climatology using 30 day running mean over 30 years
2. Define by locations and times for SST over the 90th percentile for over 5 days
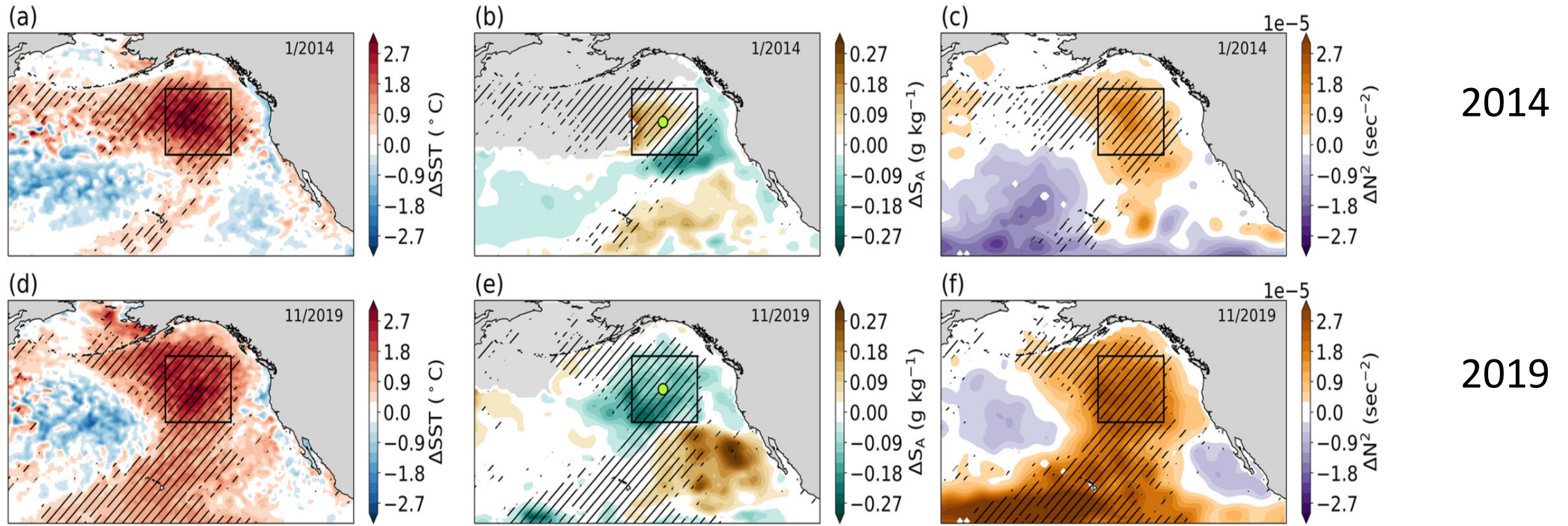3. Trend is not removed

HOWEVER:
- MHW Evolve in three dimensions
- They are spatiotemporally connected
- If the trend is not removed, the entire globe can be in MHW conditions

Example 1: Subsurface Evolution of the 2014-2018 MHW using Argo T/S: Scannell et al 2020
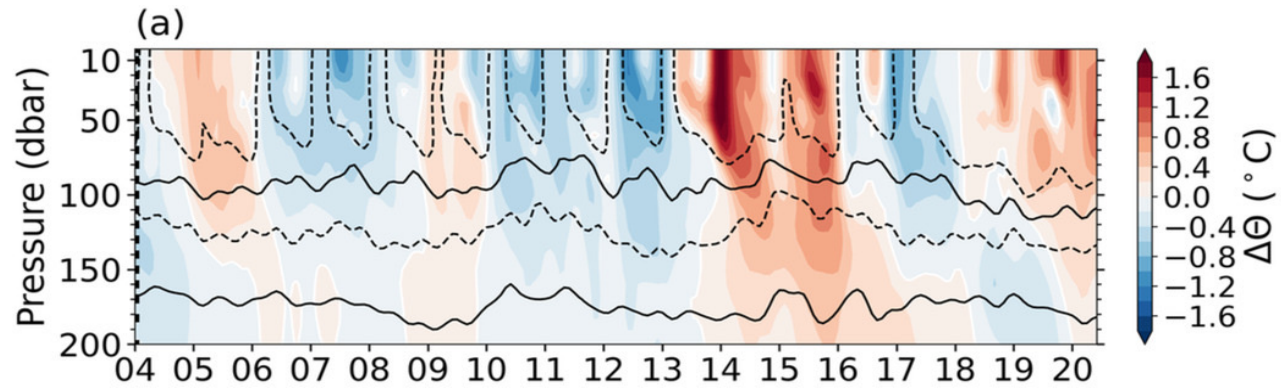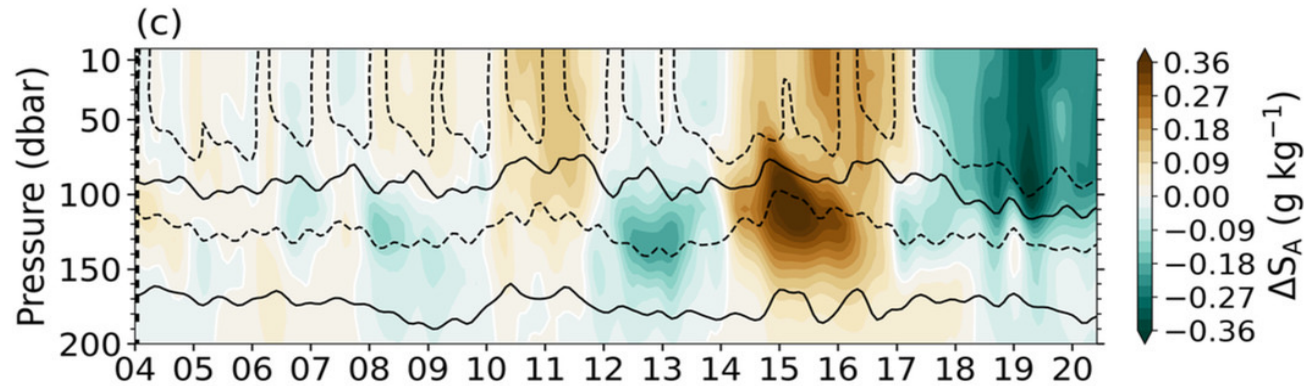

SST anomaly

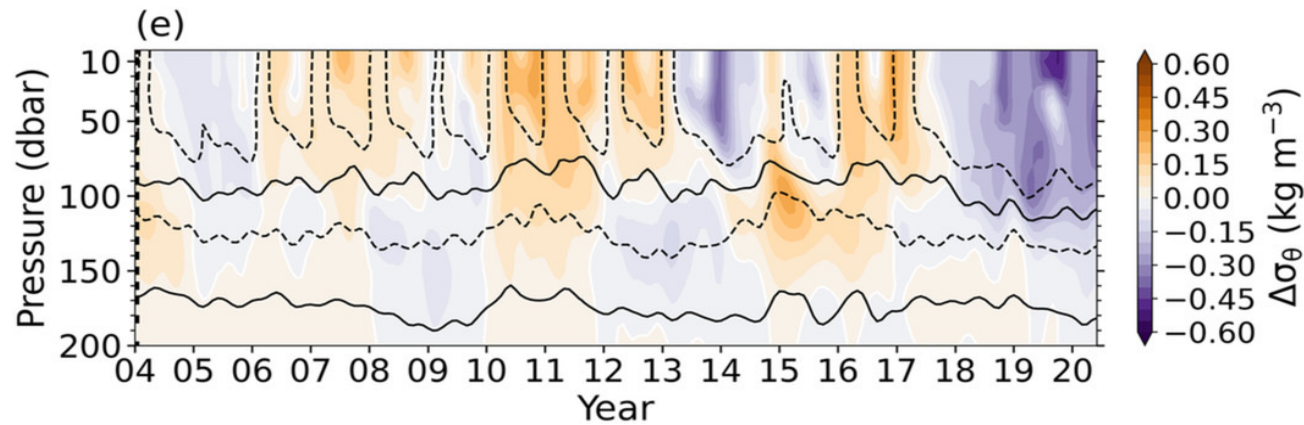SSS Anomaly

Stratification Anomaly

Subsurface Evolution Evidence of Subduction

Temperature Anomaly

Salinity Anomaly

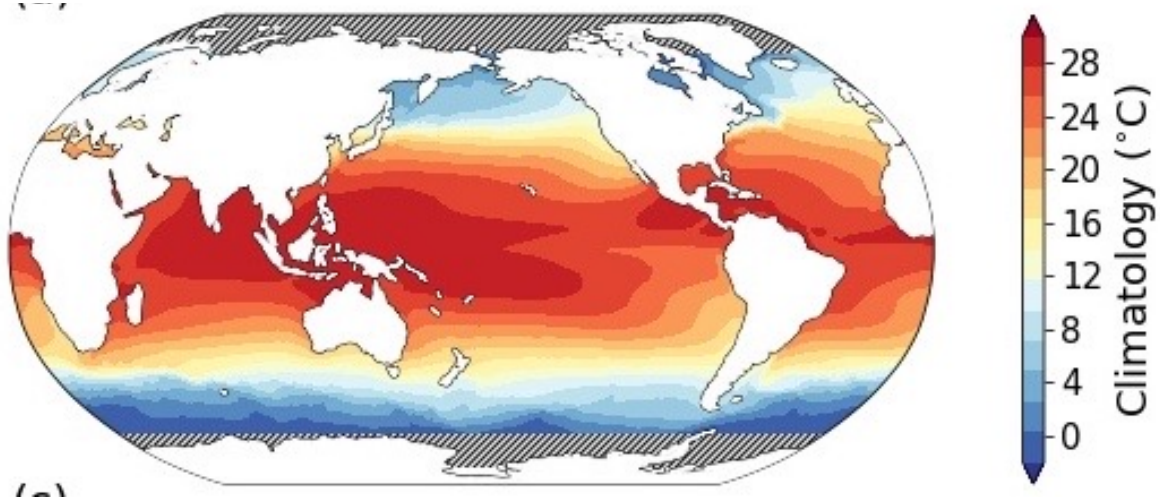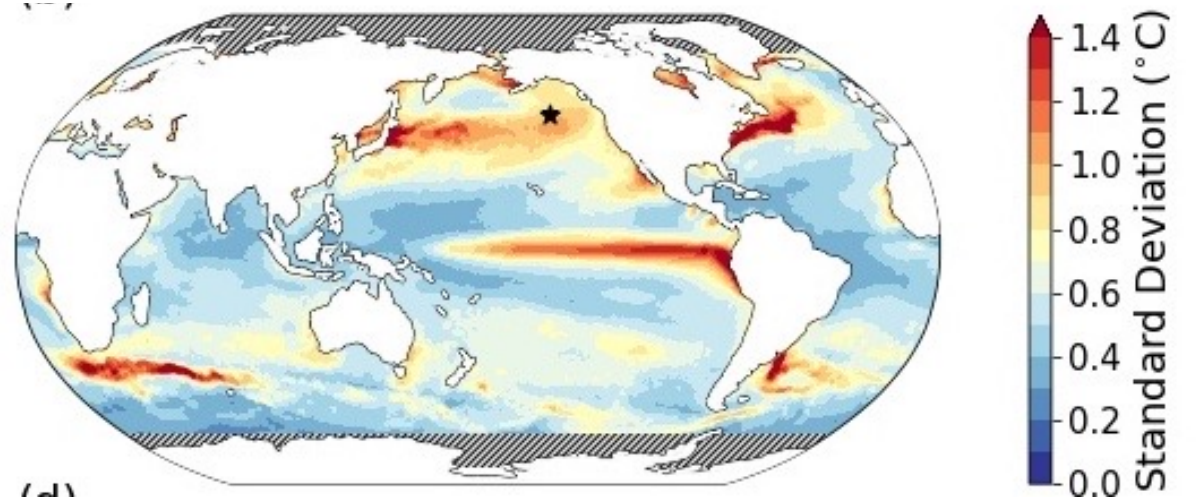Density Anomaly

Tracking MHWs in the satellite record

1. Remove trend and seasonal cycle
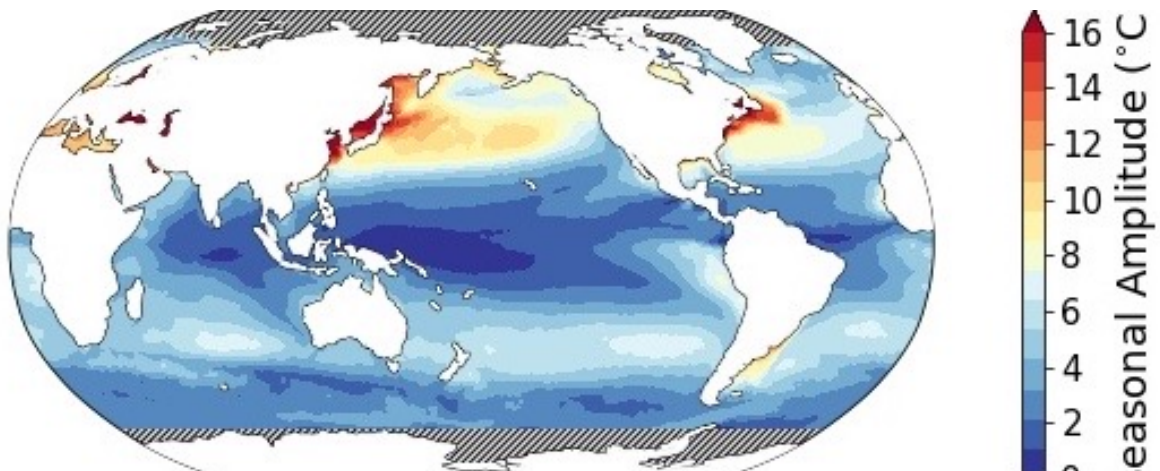2. Define by locations and times for SST over the 90th percentile for over one month
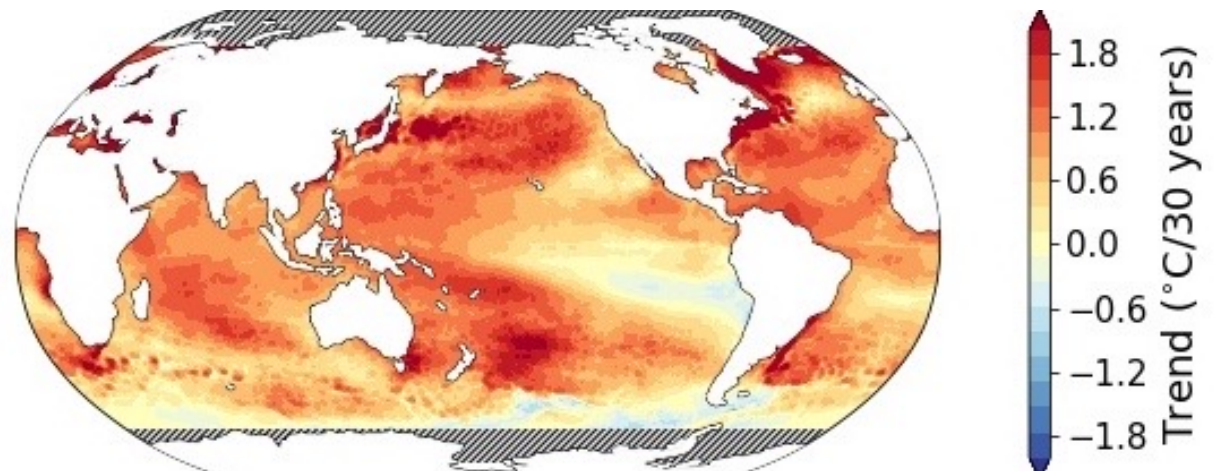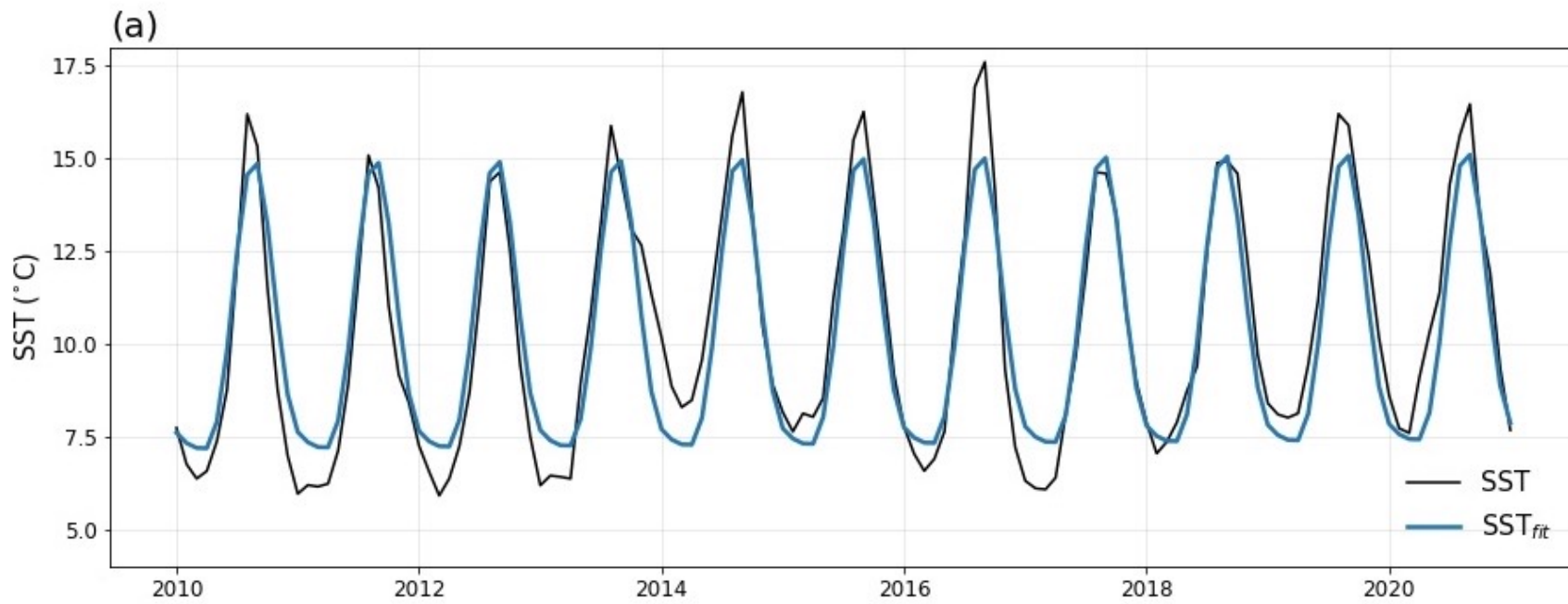
Long term mean

Standard Deviation of anomalies

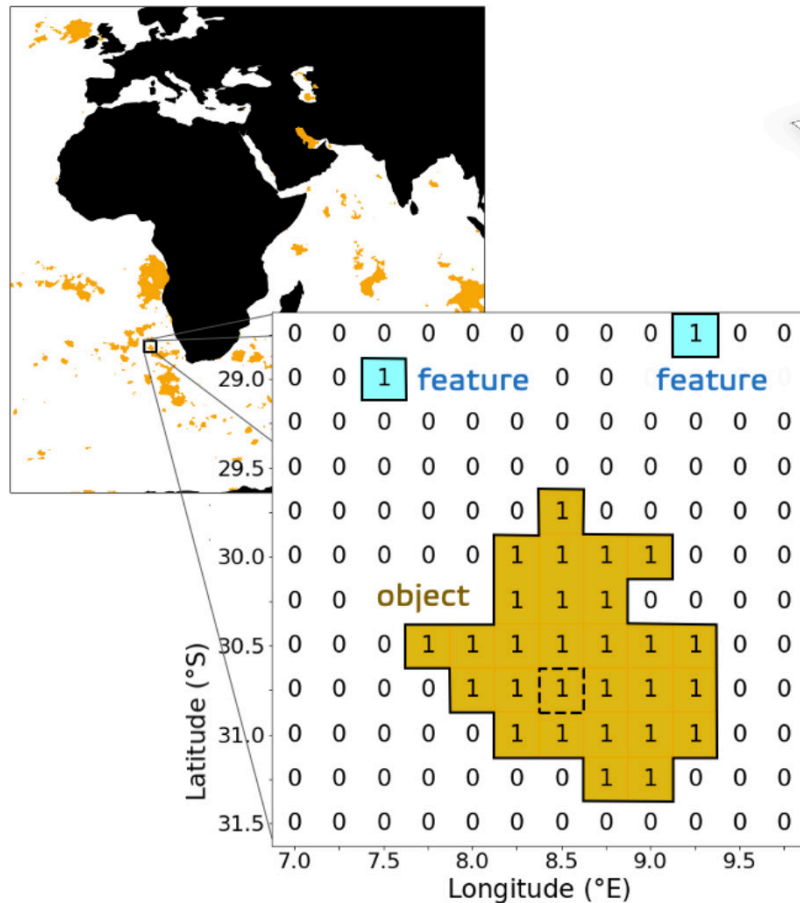Amplitude of the seasonal cycle

Trend

NE Pacific Marine Heatwaves defined after detrending and removing seasonal cycle
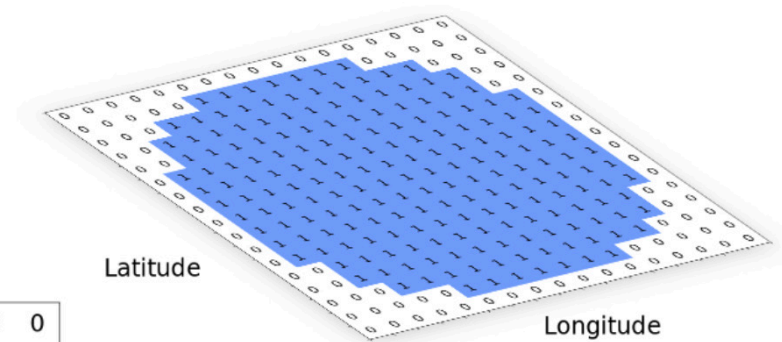
NOAA

OCETRAC: A MHW tracking software to quantify the spatiotemporal evolution
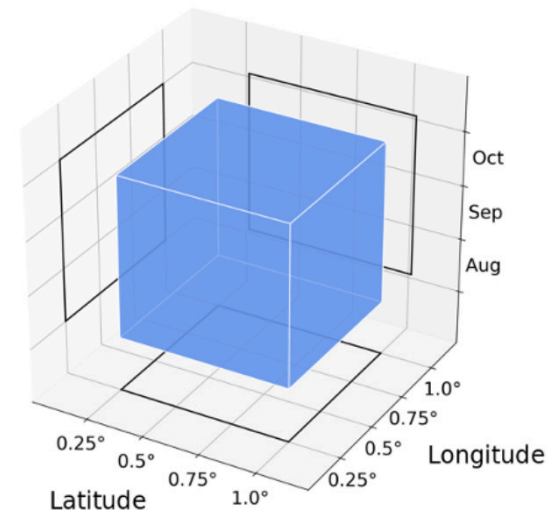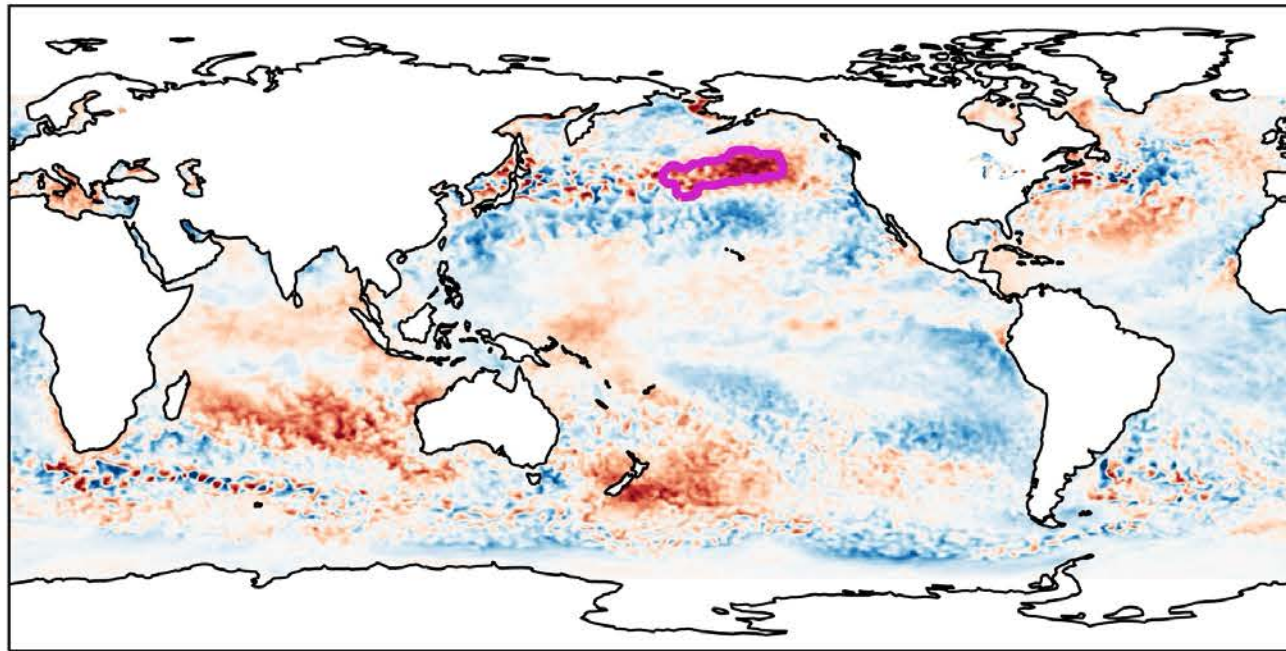## Defining and connecting objects

Tracking events; connection overlapping objects: "The Blob" 11/2013-10/2018
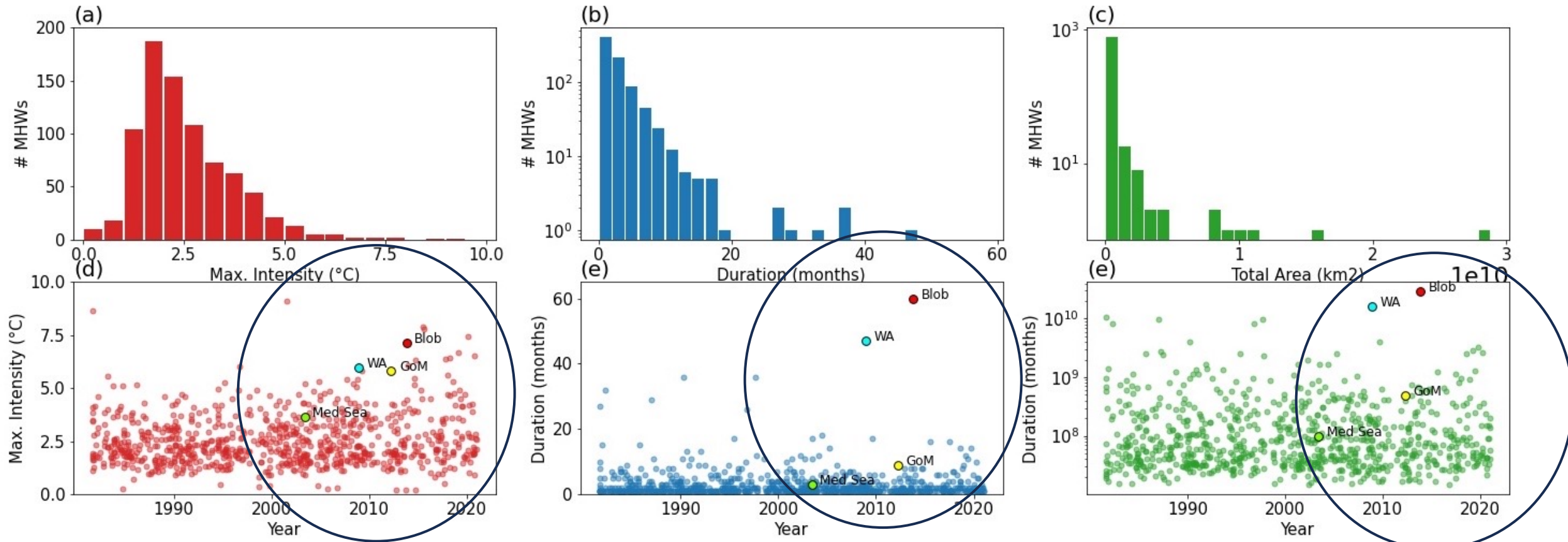

2013-11-01

The tracked MHW that contains the blob:

- Lasts for over five years
- Contains named MHWs in the
  - Northeast Pacific 2015
  - Tasman Sea 2015
  - Great Barrier Reef 2016
  - Santa Barbara 2015

MHW statistics from OCETRAC

Named MHW are intense, long and cover a larger area

# Example 2: MHWs in a large ensemble
Remove long term trends, allowing for adaptation

Use monthly averages reflecting the longer timescales in the ocean
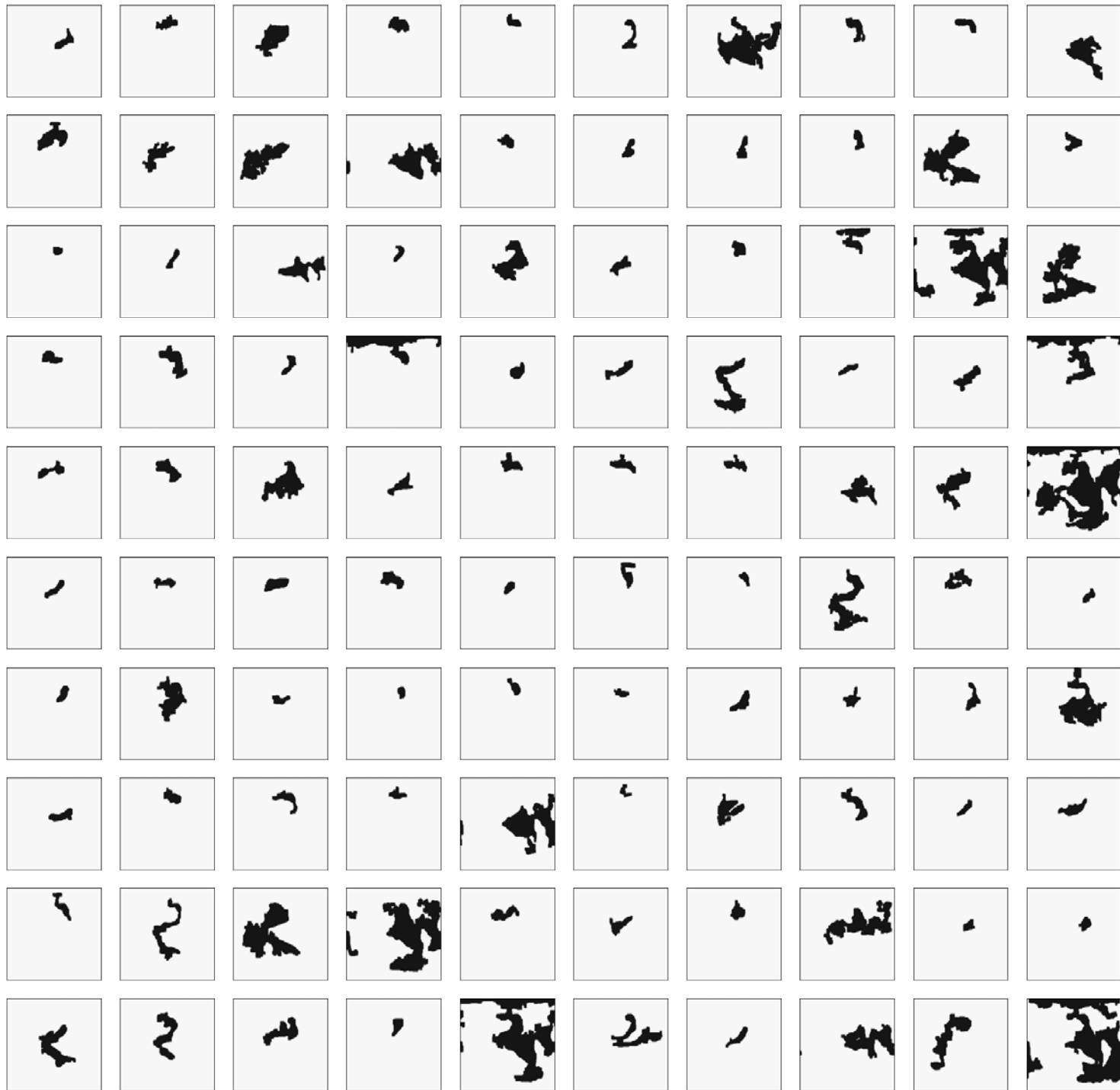
If trend is not removed: by the end of the century, the entire global would be a MHW

Allows examination of common processes across the warming ocean

Application of OCETRAC to a CESM-Large Ensemble: A shifting baseline: 1850-2015 (Cassia Cai)

Linear Trend

10 year running mean

7 degree polynomial
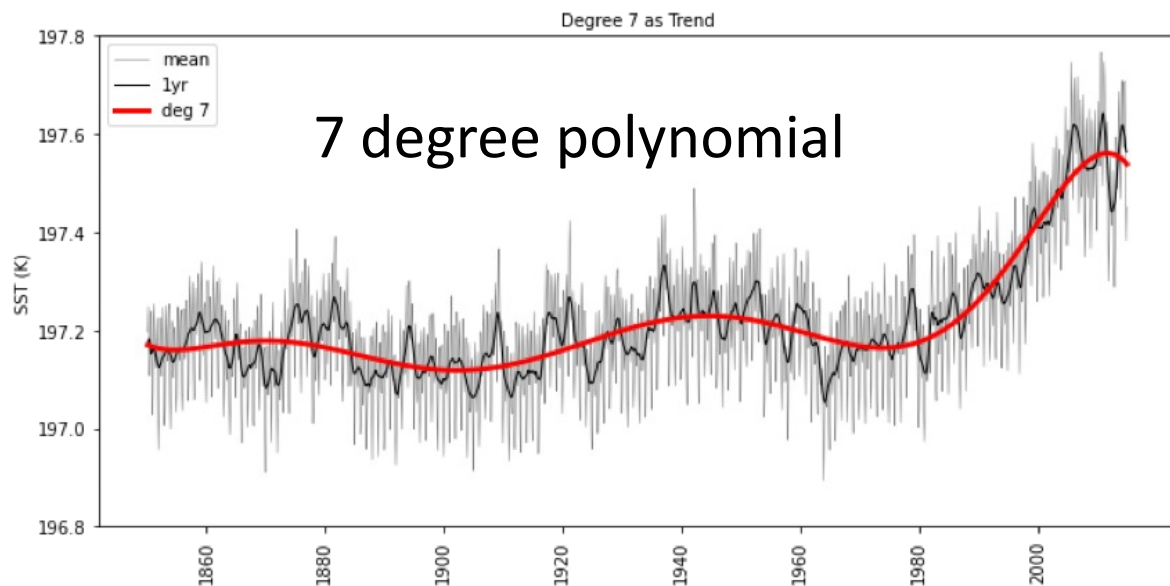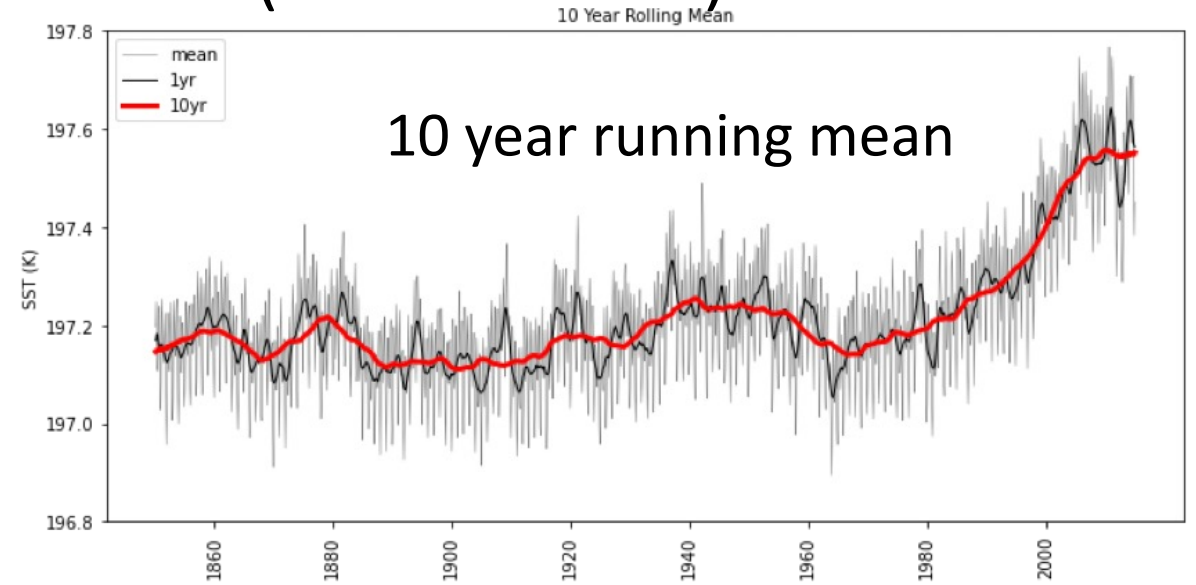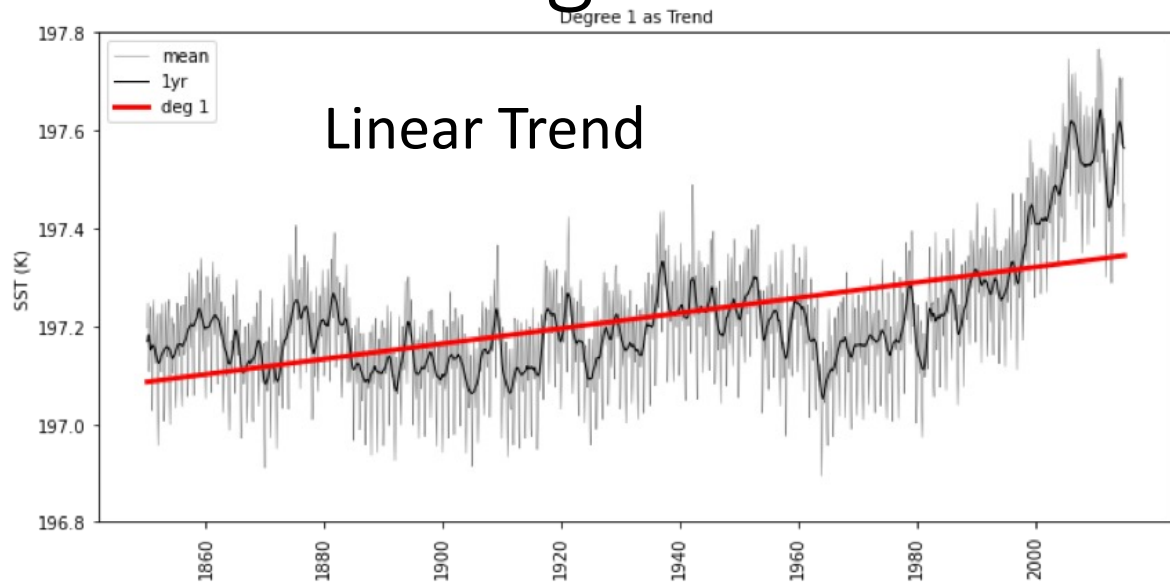
The baseline and trend matters for the size and duration of MHWs

Application to a large climate ensemble:

MHW events that have a footprint in the NE Pacific are common across the ensemble
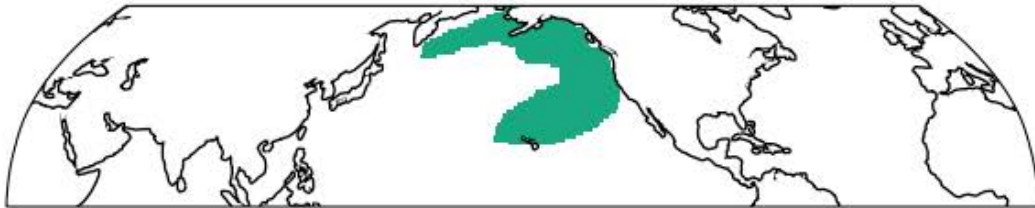
On going work:

Application of OCETRAC to SMYLE
CESM Seasonal to Multiyear Large Ensemble, May 2014 start

Ensemble 1: the Blog Starts in August 2014, lasts 11 months

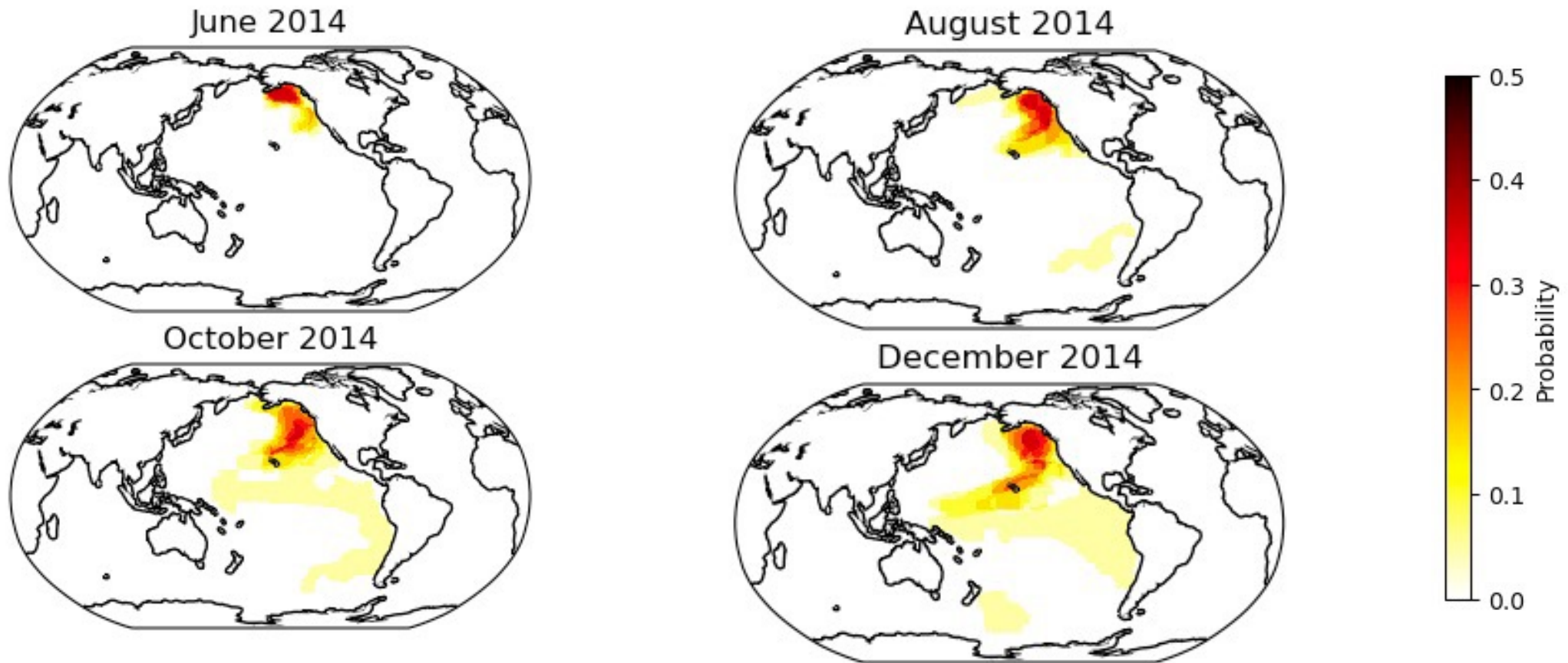August 2014

September 2014

October 2014

November 2014

Probability that the blob would occur for May 2014 prediction

Conclusions

The definition of MHWs can be nuanced and depend on the application

MHWs have a subsurface signature that can persist for years

A shifting baseline allows examination of common physical drivers and characteristics

MHWs can be globally connected, linked by atmospheric forcing